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(71) Applicant (for all designated States except US): **KONINKLIJKE PHILIPS ELECTRONICS N.V.** [NL/NL];  
Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **HERINGA, Anco** [NL/NL]; c/o Philips Intellectual Property & Standards, Cross Oak Lane, Redhill Surrey RH1 5HA (GB). **HUETING, Raymond, J., E.** [NL/GB]; c/o Philips Intellectual

Property & Standards, Cross Oak Lane, Redhill Surrey RH1 5HA (GB). **SLOTBOOM, Jan, W.** [NL/NL]; c/o Philips Intellectual Property & Standards, Cross Oak Lane, Redhill Surrey RH1 5HA (GB).

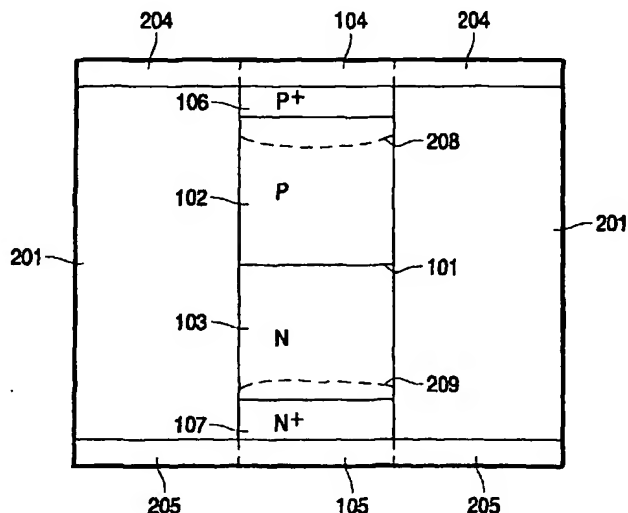
(74) Agent: **WILLIAMSON, Paul, L.**; c/o Philips Intellectual Property & Standards, Cross Oak Lane, Redhill Surrey RH1 5HA (GB).

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(54) Title: SEMICONDUCTOR DEVICE WITH A FIELD SHAPING REGION



(57) Abstract: A semiconductor device, for example a diode (200), having a pn junction (101) has an insulating material field shaping region (201) adjacent, and possibly bridging, the pn junction. The field shaping region (201) preferably has a high dielectric constant and is coupled via capacitive voltage coupling regions (204,205) to substantially the same voltages as are applied to the pn junction. When a reverse voltage is applied across the pn junction (101) and the device is non-conducting, a capacitive electric field, is present in a part of the field shaping region which extends beyond a limit of the pn junction depletion region which would exist in the absence of the field shaping region (201), the electric field in the field shaping region inducing a stretched electric field limited to a correspondingly stretched pn junction depletion region (208,209) and an increased reverse breakdown voltage of the device.



FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H01L29/06 H01L29/41 H01L29/861 H01L29/78 H01L29/73

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

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IPC 7 H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 519 741 A (KK TOSHIBA) 23 December 1992 (1992-12-23) page 3, line 22 - page 4, line 46; figures 1,3 page 5, line 9 - line 12; figure 6 page 5, line 44 - line 46	1-3, 6-15,18
X	US 2003/006458 A1 (TERASHIMA T) 9 January 2003 (2003-01-09)  page 3, paragraph '0053! - page 4, paragraph '0067!; figures 1,2  ----- -/--	1-4,6,7, 10-12, 16,18

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Morvan, D

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 09, 13 October 2000 (2000-10-13) - & JP 2000 164855 A (NIPPON TELEGR & TELEPH CORP), 16 June 2000 (2000-06-16) abstract; figure 1	1,5,7, 9-12,16, 18
X	EP 1 291 926 A (POWER INTEGRATIONS INC) 12 March 2003 (2003-03-12)  column 5, line 39 - column 7, line 41; figure 1	1,2,6,7, 10-12, 16-18
X	EP 0 823 736 A (HU S) 11 February 1998 (1998-02-11)  column 5, line 19 - line 55; figures 1A-1C column 2, line 11 - column 3, line 13	1,6,8, 10-12, 15,18
P,X	WO 03/043089 A (KONINKLIJKE PHILIPS ELECTRONICS NV) 22 May 2003 (2003-05-22) cited in the application page 9, line 16 - page 12, line 6; figure 1 page 16, line 1 - line 21; figures 5A,5B	1,5,7, 10-13, 16,18

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No  
PCT/IB2004/001527

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 0519741	A	23-12-1992	DE 69219405 D1 DE 69219405 T2 EP 0519741 A2 JP 3435171 B2 JP 5136435 A US 5323041 A	05-06-1997 11-09-1997 23-12-1992 11-08-2003 01-06-1993 21-06-1994
US 2003006458	A1	09-01-2003	JP 2003017695 A	17-01-2003
JP 2000164855	A	16-06-2000	NONE	
EP 1291926	A	12-03-2003	US 2003047768 A1 EP 1291926 A2 JP 2003179229 A JP 2004289185 A US 2003047769 A1 US 2003047793 A1 US 2003197220 A1	13-03-2003 12-03-2003 27-06-2003 14-10-2004 13-03-2003 13-03-2003 23-10-2003
EP 0823736	A	11-02-1998	DE 19632412 A1 EP 0823736 A2	12-02-1998 11-02-1998
WO 03043089	A	22-05-2003	EP 1449256 A1 EP 1449257 A1 WO 03043089 A1 WO 03043091 A1 US 2003094650 A1 US 2003094649 A1	25-08-2004 25-08-2004 22-05-2003 22-05-2003 22-05-2003 22-05-2003